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Costing Systems

At no period in its history has the foundry industry been so interested in costing as at the present time, and it is a rare event at the moment that our mail does not include a demand for some information on this subject. It was thus natural for us to examine with more than usual interest the latest publication* on costing. It has presumably been written by a refugee from Germany, who was a member of the Committees which produced the now official Nazi system of costing for iron and steel works. It must therefore be considered as having been written by an authority of high standing. Most large steelworks possess ironfoundries, yet a search through the 350 pages of this book fails to find a single reference to their existence, and probably in the eyes of the author they must be relegated to the maintenance department. Doubtlessly this is the correct method from a book-keeping point of view—but bad from a psychological one—a feature well recognised by the author. When dealing with the interpretation of balance-sheets, it is stressed that amongst other unponderable factors, *esprit de corps* may form a valuable asset or dangerous liability. To control a section of a works, where every other departmental manager is only interested in getting goods at the lowest possible cost, is not conducive to enthusiasm, and, ultimately, progress. It must be pointed out that, conversely, works costing being a service to the executives, has recently resulted in a better recognition of foundry practice, due to a search for increased life from ingot moulds.

Much of the book can be skipped by those whose interests are primarily associated with the foundry industry, but the author's notes on stocktaking should certainly be carefully studied. Moreover, the description of the official German system may reveal some useful pointers. For instance, according to it, the costs for the making of a large moulding box prepared for a special job would be spread over several years, under the heading of a "suspense account." This case, and many others such as the dealing with inter-departmental transport, activity factors, price cutting, are applicable to industries other than the large iron and steel works, so that the skipping should be done with discretion. The chapters which should be studied in detail are the earlier and closing ones, as the former interlocks the financial requirements and works costing, whilst the latter summarises the author's conclusions. There is much evidence throughout the book of the friction which is caused through the demands of costing systems, and the author is obviously doing his best to eliminate this state of affairs by creating tolerance, through the reconciliation of the divergent views of the technician and the accountancy experts. Bearing this in mind, we were surprised to read on page 305: "The best expedient [to prevent departmental friction] is to create the position of an organising superintendent whose duty it is to care for the uniformity of organisation as far as this is possible without hampering the work, and to adopt the individual measures of organisation to the peculiarities of the special cases. This superintendent, who is responsible directly to the general manager or the managing director, is working solely as a consultant; he has not the right to give orders himself, but can do it through the departmental manager concerned throughout the whole works, and if by virtue of his knowledge, experience, and especially his personality he is the right man, his influence can be beneficial." Such a superintendent, possessing as he does no executive authority, will either quickly arouse friction or resign, as his "personality" would be unable to withstand the ever-increasing accumulation of neglected suggestions. One of the largest corporations in the ironfoundry industry tried out such a scheme, and both directorate and superintendent would now agree with us, that it would have been better to employ him or a similar type of specialist as a consultant, who would report only to the managing director. We attribute the author's statement we have quoted to fatigue, for there are many signs towards the end of the book of weariness. The phraseology, to which courtesy alone must make us take a lenient view, most certainly deteriorates in the closing chapters. In such a phrase as "the technician is accustomed by his training to think first of all of time and quantity, and as a great part of his customers are technicians, this should be an additional reason for the accountant to the use of money as a measure as long as possible," the import is somewhat obscure. In a foreword, Sir William Larke highly commends the book, and even recommends it as a textbook for students taking degree courses in engineering and metallurgy. Sisco has recently suggested the inclusion of languages! Candidly, it cannot be done, and the best solution is that devised by Pearce—a

(*Continued overleaf.*)

*Economic Control of Iron and Steel Works, by F. L. Meyenberg. Published by Chapman & Hall, 11, Henrietta Street, London, W.C.2. Price 25s. net.

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The Cult of Scrap

By "ONLOOKER."

Whatever adverse criticism there may be of the Control's scheme for encouraging a greater use of secondary metal, it cannot be denied that a lead has been given to the whole industry, certain sections of which have in the past been inclined to concentrate too much on the virgin metal aspect of the supply problem. It may be contended that process scrap must almost always accrue during the process of fabrication, and that manufacturers do in fact "eat up these crusts," but unfortunately this is not uniformally correct owing to one cause and another. For example, a firm may not possess the type of foundry equipment capable of dealing with such metal scrap, or it may be that there is no foundry at all in some particular plant, in which case there is no option but to dispose of such scrap to the best advantage. In another case there may be an inherent objection to the use of scrap, and here again there is nothing to be done except to make the best use of the outside buyer. It is here that the newly launched scheme comes in, for under it provision is made for process scrap to be returned to the mill from which it originated, and in this way it is believed that the best possible use will be made of the metal. It will, at any rate, stay in that particular section of the manufacturing system to which it belongs.

That this country has in fact always consumed very considerable quantities of scrap cannot be gainsaid, but it must also be conceded that before the war a fairly big tonnage of secondary material found its way across the Channel, most of it being rather low grade stuff. Brass scrap, for example, was exported to Continental countries, and from time to time merchants specialising in this type of business were able to secure relatively good prices for this material, which was not particularly favoured by many users in the U.K. owing to heavy melting losses and other difficulties. Owing to the enforced cutting off of this outlet since the outbreak of war and greatly enhanced machining activity due to production of munitions, at times last year brass swarf accumulations reached a somewhat onerous level and values declined accordingly. At the lower levels good buying support supervened, but nevertheless action was eventually taken by the Control so as to ensure that a steady flow of swarf should be absorbed by the brass rod manufacturers. Since the beginning of the war the absence of an electrolytic refinery in this country has been commented upon more than once, and there is no doubt that a plant of this nature would be able to absorb large quantities of secondary material which at present tend to hang fire. In this connection it may be remembered that suggestions to ship copper-bearing material to the States for treatment there have been made.

However, the net result of developments during the past month has been that the country as a whole, so far as the non-ferrous metal community is concerned, is becoming more scrap minded, evidence of this coming in news that an association intended to cater specially for the interests of scrap metal merchants has been formed. It may well be that at this juncture the activities of such a body may be hampered to some extent owing to the grip maintained on all non-ferrous metals by the Ministry of Supply, but this very factor has probably been instrumental in demonstrating to the interested parties that it is distinctly advisable to speak with one voice on matters appertaining to policy. One may imagine, too, that the Control will welcome a move of this kind, for the scrap trade has always been a difficult and elusive problem for authority to tackle, and an association is bound to be in a position to furnish helpful suggestions and to comment wisely on current problems.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Plaster Patterns

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—Please allow me to reply, through the medium of your Journal, to the correspondence from "Ecossais" on "Plaster Patterns," printed in your issue of February 12.

With reference to your correspondent's remarks regarding the extent of my remarks in my letter of January 22 ("F.T.J.," January 29), I would point out that they were confined to the making of the wood pattern only, for the 20 in. dia. by 9 in. deep cylinder, and were not intended to suggest a quicker method of producing the mould. I stated at the outset that I regarded the making of a plaster pattern as outlined by Mr. Plucknett to be much quicker than the making of a wood pattern. I considered, however, that Mr. Plucknett's remarks regarding the construction of a wood pattern did not draw a fair comparison of the two methods, and therefore I attempted to describe as clearly as possible a quicker and more favourable method of constructing a suitable wood pattern.

The use of strickles for producing the mould, as suggested by "Ecossais" may or may not be the quickest method, and I had not overlooked this point. I assumed, however, from the trend of Mr. Plucknett's Paper that he was considering the job from the viewpoint of foundries, who do not practice strickle handling in their methods. Furthermore, it is doubtful whether loam moulding would be quicker than green sand moulding with a pattern, even taking into consideration the time required for the making of the pattern; one must not overlook the time required for the drying of a loam mould. This, I have no doubt, would tend to increase the total time required for producing the casting, as against green sand moulding.

In conclusion, I would like to thank "Ecossais" for his interesting remarks.—Yours,

W. WEARING, JUN.

24, Dorset Road,
Darlaston, South Staffs.
February 18, 1942.

Canadian Steel Requirements

It is estimated that Canada will be short of approximately 2,000,000 tons of steel this year, for with mills operating at capacity—a rate that has been extended by about 40 per cent. since the outbreak of war—only slightly more than half of the steel required for Canadian industry can be produced within the Dominion. To relieve some pressure on production and imports, the Canadian government placed new and rigid restrictions on the use of steel for production of materials, other than those directly associated with the war effort. These new restrictions, which will cut civilian use of steel by about 40 per cent, went into effect immediately after the turn of the year; more drastic action along these lines is under consideration.

The Minister of Munitions and Supply has also announced that raw materials and productive resources of Canada and the United States will be pooled under an all-out war production policy drawn up by the recently formed joint war production committee. Under the new policy it is proposed to concentrate production of the various war materials in plants of Canada or the United States best adaptable to some special line of endeavour, thus making use of the labour, raw materials and facilities in each country. It is understood that the policy will result in a much freer distribution of raw materials between the two countries.

Canadian production of steel ingots and steel castings in the first eleven months of 1941 amounted to 2,193,276 tons, compared with 1,825,752 tons in the corresponding period of 1940. Production of pig-iron was 1,215,957 gross tons, against 1,058,417 tons in the 1940 eleven months.

Random Shots

It is interesting to record that at the Christmas party of the North-Eastern Ohio Chapter of the American Foundrymen's Association (at which the lucky guests enjoyed an excellent turkey dinner!) the following telegram was despatched to Mr. Donald Nelson:—

"We, one thousand foundrymen attending the December meeting in Cleveland, pledge our whole-hearted support and co-operation to you, S.P.A.B. and the Government of the United States, in our 'all-out' war effort with the Axis powers. We will 'Remember Pearl Harbour.'" Foundrymen of this country will take heart that their opposite numbers in America are reacting to their Pearl Harbour incident in the same way as everyone in this country did to their Dunkirk, showing a stiff upper lip and a grim determination to avenge those disasters.

* * *

It is fairly common knowledge amongst foundrymen that Wilkinson (either John or his brother), during the 18th century, set up ironworks for the Duc de Caze in Decazeville, a small but important metallurgical centre in the heart of France, but apparently he was not the only Englishman of that period to possess foundry interests abroad. Going through a pile of old correspondence from a bank in the Cantal department of France (in an effort to amass a good collection of French post-marks), "Marksman" suddenly came across the familiar name of Mather. It appears that "Mather, *Père et Fils*," possessed a foundry in Toulouse which, at least, was flourishing in 1860, for their credit at the bank seemed to be higher than any of the others! It may be, of course, that the name is French as well as English, but "Mather" has a very familiar ring both in foundry and engineering circles in this country. It would be interesting to know whether "Marksman" has found a long-lost ancestor of the Mathers of the Ashford foundry, or whether Monsieur Mather was a scion of the engineering family of that name in Manchester. There was quite a variety of reasons for Englishmen of Victorian days being found in such odd corners of the globe. Often it was the "bad lad" of the family who was cut off with a shilling and dismissed the country by a stern and irate parent. Sometimes a genuine desire for a more equable clime than the industrial North of England drove men to the South of France; whilst it was not uncommon that economic conditions themselves made it necessary for some member of the family to start afresh elsewhere, as when the boom in the manufacture of textile machinery came to an end and was no longer able to support a father, seven or eight sons and a few odd cousins into the bargain.

* * *

A friend of "Marksman," who has become super-paper-conscious, has passed an extensive library of commercial catalogues to salvage. His itch to be of service still remaining, he is getting other catalogues and trade lists from his friends and dumping them also as salvage forthwith. He is braving the day of reckoning when the owners ask for the return of their literature, but meantime he is doing a national service.

"MARKSMAN."

Costing Systems

(Concluded from previous page.)

post-graduate course whereat visiting lecturers would endeavour to supply the missing links of the complete technological chain.

So far as the foundry industry is concerned, Meyenberg's book is a work of reference, to be consulted by those charged with the reorganisation of a concern or seeking the solution of particularly knotty problems.

The Manufacture of Crankshafts in High-Duty Cast Iron*

RESULTS OF EXPERIMENTAL TRIALS OF CAST CRANKSHAFTS IN PLACE OF STEEL FORGINGS

By E. M. CURRIE and R. B. TEMPLETON

The object of this Paper is to bring to the attention of engineers and designers the possibilities of substituting steel forgings by high-duty iron castings and, secondly, to place before them details of such results as have been obtained from experimental trials by engine builders, as well as the results obtained by various manufacturers in replacing steel forgings by castings in their crankshaft production.

On the matter of substitution there is no doubt that shortage of steel and the difficulty in obtaining forgings, owing to war production requirements, have made this a matter of urgency. It is perhaps unfortunate that the trend of opinion among engineers is conservative towards the idea of adopting a cast material for a component which is highly stressed, and the development of this process of substitution has been retarded because, before committing themselves to the change-over, engineers feel that despite proved scientific and technical data, they must now carry out long-term practical test and experiment on their works' engines.

Wartime conditions make it difficult for these experiments to be carried out with that degree of thoroughness and care which are so essential in obtaining correct data and results. These conditions apply more to the foundries where an important development of this sort should be segregated from the routine rush, and be supervised under almost laboratory conditions.

The authors are of opinion that the foundry aspect of this Paper should have prime consideration because experience has indicated that such failures with cast crankshafts as have occurred, have been due largely to some factor of design which could not or would not be modified to suit the foundry recommendation.

Redesigning Indicated

To expect a cast shaft to follow rigidly the design of a forged steel crankshaft is unfair, and is obviously unsound practice, and while the authors agree it is sometimes impossible to modify existing engine dimensions to suit a cast shaft, they are of opinion that such things as balance weights, fillets and web shapes can often be modified with advantage to suit foundry requirements.

Extensive researches have been and are now being carried out to ascertain the suitability of the modern high-duty cast irons as materials for use in crankshafts, and the results of these researches show that these irons have certain physical properties which make them even more suitable than steel. All these results, however, go by the board unless the fundamental principle of getting a sound casting is kept first and foremost in the designer's mind. Test-bar results which show very high tensile strengths are often misleading because as higher strengths are obtained, the difficulties of the casting process increase. A perfectly sound casting made in an iron of 25 tons tensile strength is infinitely better than one not quite so sound made in an iron of 30 tons tensile, and if this vital aspect is not overlooked or ignored then successful results can be achieved.

It will be agreed that the properties most desirable in a highly stressed component should be a combination of such properties as will ensure that the component is able to function during its service life with safety and absence of failure or breakdown from any cause or combination of causes.

Why Crankshafts Fail

The main reasons for unsatisfactory performances in a crankshaft are fatigue failure, poor wear values, inability to withstand shock, etc., and all these causes have their own particular effect on performance, but they are so closely inter-connected that it is impossible to say with certainty where one cause begins or the other ends, or to isolate any one cause entirely as the reason for failure or unsatisfactory performance.

For instance, a casual post-mortem on a crankshaft might indicate that its failure was due to fatigue, but possibly fatigue is only the cause of final breakdown. It may be that heavy wear on the bearings and journals has, due to slight misalignment of the shaft, set up such high operational stresses that fatigue has developed as a secondary cause.

As in all branches of engineering the iron-foundry industry has had to keep pace with intensive scientific progress, and it might be said with confidence that the technique of this particular industry has been revolutionised during the past ten to fifteen years.

In the ironfoundries where high-duty irons are being made, this progress has perhaps been more remarkable than it has been in those foundries which do not have to comply with the higher specifications now in use, and the development of the modern high-duty irons has, by precise metallurgical control, produced a dependable and consistent engineering material which can cover a wide range of applications and physical properties.

Possibly the most outstanding instance is the application with which this Paper deals. Before the era of the internal combustion engine some of the earliest crankshafts were made in cast and wrought irons, but with the development of steel with its higher strengths and ductility, engineers turned away from cast iron and its possibilities and properties were in many cases forgotten.

Research into the study of high-duty irons for crankshafts is being intensified, and evidence of results in practical use are being gradually accumulated. These data and information are proving to be of great value both to metallurgists and designers, and from this information emerges the fact that when the design of a cast crankshaft has been made with correct appreciation of the characteristics of high-duty cast irons, then it can be stated that satisfactory performance is assured.

Field for Cast Crankshafts

It will be readily appreciated that it is in the medium and small crankshafts with offset throws and integral balance weights that the cast crankshaft scores. Obviously, for many reasons, the largest engine crankshafts normally made in several parts and shrunk together, do not enter into this particular résumé, nor is it the authors' intention to give comparisons of the use of alloy and cast steel shafts with cast iron. In America an eight-cylinder Diesel engine is being made with a 10-in. diameter crankshaft over 12 ft. long, which is to be cast in Meehanite metal.

In large engines, mild steel of 30 to 35 tons tensile is generally used. This is a material which can be easily manufactured, heat-treated and is of sufficient ductility to prevent failure and damage from various stresses arising during service. In the majority of smaller car engines, tempered high carbon and high tensile alloy steels are used which give good wearing surfaces in bearings and journals. Recent practice, however, has tended towards cast steel or special irons which attracted the engineer primarily because of their cheaper and speedier production.

Advantages of Cast Material

Shafts may easily be lightened by coring out and this eliminates unnecessary weight; less material is used for the same size crankshaft when cast as compared with a forging. A casting also has better wear resistance, high fatigue and damping properties combined with rigidity, and reduced resonance and gives smoother running. These factors are leading to the rapid adoption of cast iron for this purpose.

Expensive dies, forging mills and heat-treating plants are not necessary for castings. Machining costs are considerably reduced; not only can a cast-iron crankshaft be machined more quickly than high alloy or normal steels, but a considerable saving in material is made. Frequently forged crankshafts may have as much as 50 to 80 per cent. material to be removed in machining, whereas a casting made to normal limits can be regularly produced having no more than 5 to 10 per cent. metal to be removed.

The cost of wood or metal patterns is only a fraction of forging dies and, furthermore, the putting into production of cast-iron crankshafts is only a matter of days compared to the preparation and work necessary to produce the forging die. Many new and experimental designs of shaft can be made and tried out cheaply and alterations made quickly. The production of the cast-iron shaft by machine moulding methods is far speedier than forging practice.

Physical Properties of Cast Crankshaft

The properties of cast iron of importance to crankshaft designers are: (1) Tensile strength; (2) fatigue strength; (3) notch sensitivity; (4) torsion strength; (5) damping capacity; and (6) wear resistance. The authors have for some considerable time had exceptional opportunities of studying and furthering the development of cast crankshafts in the high-duty cast iron known as Meehanite metal, which is manufactured under extremely close metallurgical supervision and made to definite specifications and accurately controlled physical properties.

It will be appreciated that if, therefore, Meehanite metal is given undue prominence in what follows, this is not intended as a reflection on many other processed and alloy high-duty irons used for crankshafts and camshafts, etc., but is merely a record of the authors' personal experiences.

The fundamental basis of the production of high-strength cast irons to-day does not wholly depend on chemical analysis or on the addition of this or that alloy. Rather does it depend on the production of a proper structure and arrangement of the main constituents of cast iron, namely, graphite, pearlite, and phosphide eutectic, with a minimum of free ferrite, cementite and minor inclusions such as manganese sulphide, together with a control of the rate of graphite distribution on the cooling down of the metal to the solid state.

The structure aimed at for Meehanite cast crankshaft material is produced by a control of the quantity of total carbon together with processing to give proper balance between the combined and graphitic carbon contents in a matrix of fine sorbopearlite. Superheating and

* A paper presented to the Institute of Marine Engineers, to which body thanks are accorded for permission to reprint this slightly abridged version.

Cast Crankshafts

precise control over the melting furnace refines the graphite and grain structure, and final processing in the ladle of the molten metal produces the structure which is known to have the highest physical results required for a specific purpose.

Tensile Strength

Meehanite irons produced in this manner have tensile strengths as cast ranging from 25 to 32 tons per sq. in., and after simple heat-treatment are capable of giving 35 to 45 tons per sq. in. Specially processed Meehanite has given as much as 50 tons per sq. in. tensile after heat-treatment.

The judicious use of alloys will sometimes enhance the values of certain physical properties, and Meehanite metal made for crankshafts sometimes contains percentages of such alloys as copper, chromium, molybdenum, nickel, etc.

Fatigue Strength and Notch Sensitivity

When failure occurs in crankshafts, this failure, as in the majority of engineering structures which are subject to fluctuating stresses, is due to fatigue, a property which is fundamental and must be considered in relation to tensile strength.

Due to the relatively modern development of high-duty cast irons, this property has not yet received the full attention it deserves.

A considerable number of investigations on

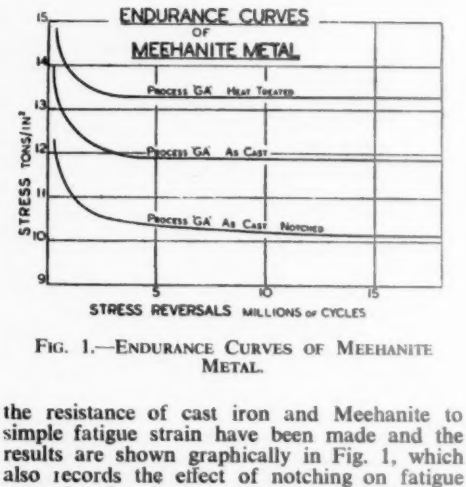


FIG. 1.—ENDURANCE CURVES OF MEEHANITE METAL.

the resistance of cast iron and Meehanite to simple fatigue strain have been made and the results are shown graphically in Fig. 1, which also records the effect of notching on fatigue strength. In view of the effect of such stress raisers as sharp corners, oil channels, etc., on crankshafts, this latter property becomes very important.

It has been generally established that as the tensile strength of cast iron increases so does the material become more sensitive to notch effect, but in no case has any investigation shown that the endurance limit of a notched cast-iron bar is less than that of steel. Many tests have revealed that the sensitivity of steel to notching is in the order of 35 to 55 per cent. of the endurance limit, while that of normal high-test cast iron averages 10 to 20 per cent. reduction of the endurance limit.

This would suggest that more generous fillets are desirable in strong irons and the importance of eliminating notches wherever possible.

Many investigators have raised the theory that the graphite flakes act as stress raisers. This is not altogether true, as the graphite if in proper form and quantity can help to prevent failure. The tough pearlitic matrix of Meehanite contributes high strength to the design, but the graphite flakes will dissipate stress over the whole structure and prevent microscopic cracks from leading progressively to fracture under fatigue stresses.

Thus, while it may be generally accepted that the higher the strength of a cast iron the more susceptible it becomes to the influence of notches, keyways, poorly designed fillets, re-entrant angles, sharp corners, etc., this must be treated with a certain amount of reserve, and actual figures obtained from test data cannot be relied upon for definite calculations. It can, however, be stated that the ill-effect of poor design would be less felt in a Meehanite crankshaft than it would in a steel shaft.

The N.P.L. Tests

From the point of view of crankshaft designers, simple flexual tests do not tell enough. An attempt to measure the properties of cast materials used for crankshafts was made at the National Physical Laboratory by Gough and Pollard on behalf of the Institution of Automobile Engineers (published in the "I.A.E. Journal," March, 1937), which recognised that in order to get more informative results from laboratory tests, a test machine that would reproduce in some measure the static twisting and bending moments and the cyclic twisting and bending to which a crankshaft is subjected in service, was required. The machine developed by Gough and Pollard give data on "combined" stresses and determined:—

(*a*) The fatigue limit under cycles of reversed plane bending stresses.

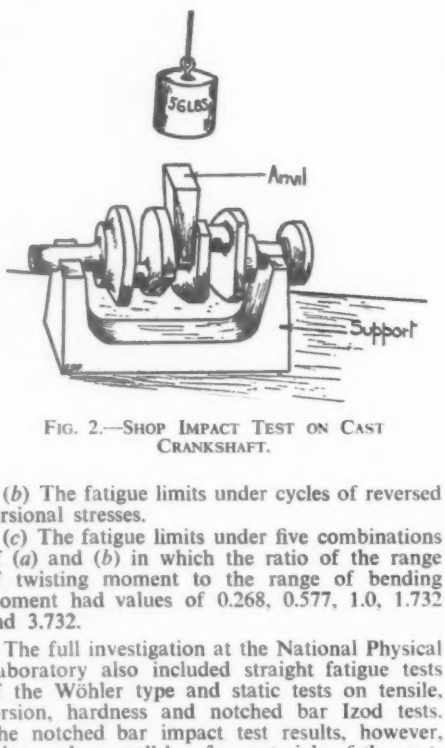


FIG. 2.—SHOP IMPACT TEST ON CAST CRANKSHAFT.

(*b*) The fatigue limits under cycles of reversed torsional stresses.

(*c*) The fatigue limits under five combinations of (*a*) and (*b*) in which the ratio of the range of twisting moment to the range of bending moment had values of 0.268, 0.577, 1.0, 1.732 and 3.732.

The full investigation at the National Physical Laboratory also included straight fatigue tests of the Wöhler type and static tests on tensile, torsion, hardness and notched bar Izod tests. The notched bar impact test results, however, using such a small bar for materials of the cast-iron type, are relatively useless.

Five different materials were tested, all of which were developed previous to 1937 as crankshaft materials. All are cast materials, although the one designated "alloy steel" received an annealing treatment, and the copper-chromium iron received a short malleable type anneal. The remaining three were tested as cast. It should be noted by engineers who wish to utilise the data secured by this investigation that while, according to the state of metallurgical knowledge existing at the time these materials were tested, a close study of the methods used for preparing the test samples themselves left considerable doubt as to the state of the compositional structure of each of the test bars which would give the best possible result obtainable in each of the various types of materials used. This is recognised and emphasised by Gough and Pollard, and is a most important point in any consideration of the results obtained, and as several different methods were employed for obtaining these bars, this makes true comparison of the relative final values for a scientific basis for design a most difficult and complicated affair.

The five materials tested were:—

(1) *Alloy Steel.* Billet annealed at 860 deg. C. Test-pieces were then cut from this billet and were subsequently oil-quenched from 860 deg. C. and tempered at 650 deg. C. before testing. Analysis: C, 0.32; Si, 0.23; Mn, 0.88; S, 0.04; P, 0.03; Ni, 2.42; Cr, 0.49; Mo, 0.38; Cu, 0.13 per cent.

(2) *Copper-Chromium Iron.* This material only develops its maximum physical properties following annealing treatment. In this case, test bars closely approximating the final test size were heated to 900 deg. C., held for 20 mins., cooled in the furnace to 540 deg. C. in 60 mins., and then allowed to cool normally in air. Analysis: C, 1.56; Si, 1.16; Mn, 0.44; S, 0.049; P, 0.067; Cr. 0.46; Cu, 1.75 per cent.

(3) *Processed High-Test Iron.* A cupola melted iron, made under controlled furnace conditions, which would normally solidify as a white iron, but by interference with normal graphitisation by ladle processing, solidifies with a definite sorbo-pearlitic-graphitic structure. In the original report this iron bears the meaningless descriptive term "inoculated iron." Tested in the "as-cast" condition. Analysis: C, 2.75; Si, 1.59; Mn, 0.88; S, 0.073; P, 0.076; Mo, 0.29 per cent.

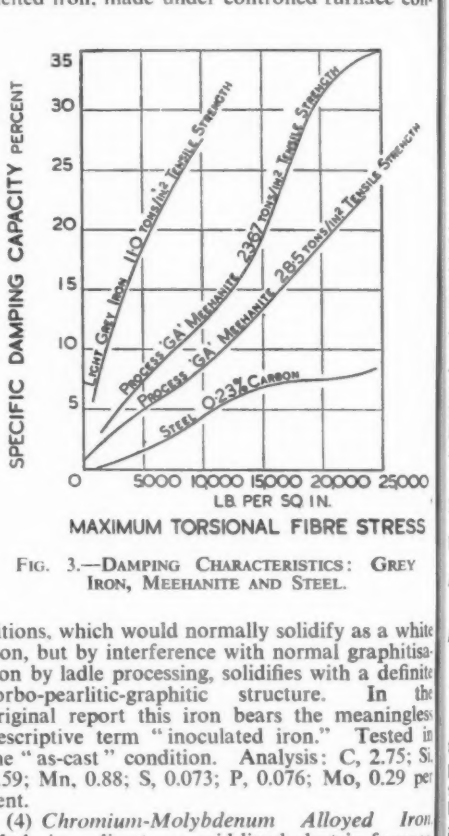

SPECIFIC DAMPING CAPACITY PERCENT
LIGHT GREY IRON 11.0 TONS/IN² TENSILE STRENGTH
PROCESSED 'GA' MEEHANITE 23.67 TONS/IN² TENSILE STRENGTH
PROCESSED 'GA' MEEHANITE 28.5 TONS/IN² TENSILE STRENGTH
STEEL 0.23% CARBON
LB. PER SQ. IN.
MAXIMUM TORSIONAL FIBRE STRESS

FIG. 3.—DAMPING CHARACTERISTICS: GREY IRON, MEEHANITE AND STEEL.

(4) *Chromium-Molybdenum Alloyed Iron.* Made in a direct arc acid-lined electric furnace. Analysis: C, 3.28; Si, 2.19; Mn, 0.95; S, 0.095; P, 0.17; Cr, 0.42; Mo, 0.95 per cent.

(5) *Nickel-Chromium Alloyed Iron.* Cupola melted. Tested in the "as-cast" condition. Analysis: C, 3.36; Si, 1.22; Mn, 0.92; S, 0.113; P, 0.124; Ni, 1.87; Cr, 0.47 per cent.

Table I gives a summary of the majority of results obtained in this investigation, which undoubtedly represents the best collection of information made on the subject of crankshaft material in recent years. It is to be hoped that in view of the comparatively rapid advances in the production of these materials under the pressure of the present national emergency, that this investigation will be carried further at the earliest possible opportunity.

Single Impact Tests

While this property is not of direct value in assessing the suitability of high-test cast irons

Cast Crankshafts

for crankshafts, it does indicate in a measure the toughness of the material to withstand the repeated hammering that a crankshaft may get should journals and bearings wear badly. There is not as yet a recognised standard impact test for cast irons. The standard Izod test bar for steel, a 10 mm. square bar with a 1 mm. deep 45 deg. notch on the striking side, is too small to give any measurable difference of degree of shock resistance in a naturally notched material such as cast iron. Even on cast steels, the test shows marked variations of energy absorption on the same samples.

It can be stated, however, that as far as cast irons are concerned agreement on standardisation of bar size for the single impact (Izod) test is in sight between various authorities and the new bar will utilise a 1.1 in. dia. bar having a 0.05 in. deep groove to localise the fracture. This will be broken on the standard 120 ft.-lbs. Izod machine in a special vice to accommodate the larger sized bar, and a wider range of results will be secured to differentiate between the various types of cast irons available to the engineering industry.

TABLE I.—*Summary of Tests Made at N.P.L. on Five Crankshaft Materials.*

	(1) Alloy steel.	(2) Cu-Cr iron.	(3) Processed high test cast iron.	(4) Electric furnace Cr-Mo iron.	(5) Ni-Chromium iron.
Ultimate tensile strength—tons per sq. in.	52.3	32.2	23.3	20.8	18.8
Modulus of elasticity—lbs. per sq. in. × 10^{-6}	29.3	26.8	21.7	20.1	18.7
Brinell hardness	260	260	245	280	265
Izod single impact bar—10-mm. sq. bar, 2-mm. notch	24.8	1.2	1.5	0.8	0.4
Torsional modulus of rupture—tons per sq. in.	46.5	38.6	31.9	32.7	21.1
Total twist at fracture—($L/d = 8\frac{1}{2}$) deg.	846	96	82	53	16
Modulus of rigidity—lbs. per sq. in. × 10^{-6}	11.5	11.4	8.6	8.6	7.1
Fatigue limit (Wöhler)—tons per sq. in.	±22.3	±21 to ±19	±12.9	± 9.4	± 8.9
Endurance ratio	0.43	0.65 to 0.59	0.55	0.45	0.47
Alternating torsional fatigue limit—tons per sq. in.	±14 to ±12.3	±14.7 to ±13.9	± 9.7	± 8.4	± 7.1
Endurance ratio	0.27 to 0.24	0.46 to 0.43	0.42	0.40	0.38
Fatigue limits from combined stress machine					
Reversed bending stresses—					
Fatigue limit—tons per sq. in.	±26.6	±18.2	±12.9	±10.8	±10.6
Endurance ratio	0.509	0.564	0.554	0.519	0.564
Reversed shearing stresses—					
Fatigue limit—tons per sq. in.	±17.9	±14.4	±11.4	±10.9	± 8.9
Endurance ratio	0.342	0.446	0.489	0.524	0.473

Table II gives a brief idea of some results taken from an investigation of the impact properties on over a thousand different samples submitted. While, generally speaking, there is a broad relationship between the tensile strength and impact resistance of a cast iron, this does not follow exactly, and the test is purely empirical.

In order to get a practical shop test of the impact properties, the arrangement shown in Fig. 2 was made. It will be seen that the end bearings of the crankshaft are supported in two vee blocks on a bedplate. Another vee block is placed on the centre bearing and a 56-lb. weight is raised by a pulley and dropped from various heights directly on to this vee block, so that the impact shock is concentrated on the middle bearing. The machined crankshaft illustrated is 2 ft. 3 in. overall length, diameter of bearings 3¼ in., and the machined weight is 130 lbs. One particular casting has been subjected to over fifty blows of this weight falling from a height of 5 ft. and is still unbroken.

It is not suggested that crankshafts should have a drastic shop test of this sort in order to ascertain if there are any flaws in the casting, as such a test would be dangerous and might tend to damage perfectly sound castings if the load applied was out of proportion to its designed loading. The test has been made on castings which were defective for some reason or other in order to get a rough guide as to the general toughness and shock-resisting properties of the design, and to tabulate and compare the results obtained over a series of varying designs and dimensions.

Torsional Strength

Comparatively little work has been done in securing complete data on this property of cast iron. With the introduction of cast material for crankshafts and similar applications where material is subjected to some torsional strain, interest is again being taken. Apart from the results obtained by Gough and Pollard (Table I) and Draffin and Collins (A.S.T.M. Preprint No. 43, July, 1938) and one German worker, very little has been done to study this property to finality. However, in view of the newer types of designs for hollow cast crankshafts, Draffin and Collins' work on the torsional properties of hollow specimens is worth noting. Briefly, they found that the maximum unit strain and the modulus of rupture were found to decrease as the wall thickness decreased. Their results, however, were done on specimens of ¼ in., ½ in. and ½ in. wall thickness. From the results of many investigators it is now generally established that the fatigue strength of large test-pieces is less than that of small test-pieces, but on the other hand notch sensitivity increases with the test-piece sizes.

Damping Capacity

While it has long been recognised that the ability of cast irons to "damp out" or absorb vibrations is extremely good, it was not until recent years with the introduction of welded structures and castings for fast-moving machine parts, and for highly stressed parts, such as crankshafts, that this property received proper attention. Unfortunately, little published data exist on the different damping capacities of various irons and steel.

This property, which prevents the building up of resonance stresses to critical proportions, is related to the shape and quantity and distribution of the graphite particles, and it is necessary to maintain a proper balance between tensile strength, notch sensitivity and damping capacity when using such materials for crankshaft applications.

The lower the notch sensitivity of an iron, the higher is the damping capacity, and it will be remembered that in general the higher the tensile strength of an iron the more sensitive it becomes to the effect of notches, grooves, etc.

Fig. 3 gives the comparative damping capacities of various materials. A free interpretation of these figures shows that Meehanite

TABLE II.—*Mechanical Properties of Various Grades of Cast Iron.*

Iron.	Tensile strength in tons per sq. in.	Transverse strength on 1.2-in. dia. bar, 18-in. centres. Breaking load lbs.	Deflection. In.	Grooved Izod bar, 1-in. root dia. Ft. per lb.
Meehanite process "A"	26.0	3,430	0.31	68
Meehanite process "A"	24.6	4,050	0.30	52
Meehanite process "B"	20.4	3,760	0.32	46
Meehanite process "C"	18.5	3,200	0.26	38
Cylinder class iron	16.18	2,760	0.27	32
Engineering grade iron	14.35	2,635	0.24	24
Common cast iron	11.5	2,020	0.20	18
Stove plate type iron	9.6	1,730	0.18	8

is from four to seven times more efficient than a 0.23 per cent. carbon steel in absorbing vibration in relatively low stress ranges. Due to the form of the graphite in a Meehanite iron structure, it is unique in its ability to maintain its high damping capacity at stress ranges near the endurance limit.

TABLE III.—*Percentages of Energy Dissipated.*

Energy dissipated by end. cycle.	Steel.	Process "A" Meehanite.		Process "E" Meehanite.	
		23.6 tons tensile.	28.5 tons tensile.	16.6 tons tensile.	18.1 tons tensile.
First	9	36	24	32	24
Tenth	50	85	85	92	89
Twentieth	75	93	95	98	97

From records made on a Foppl-Perts machine on Meehanite and steel, the extent of the energy absorbed from the vibrations induced by a torsional stress of 10 tons per sq. in. is given in Table III.

(To be continued.)

The Nickel Bulletin

The January issue of the "Nickel Bulletin" contains abstracts of recent important work on the spot welding of high nickel alloys and on weldability tests for nickel steels. Other work abstracted refers to spot tests for the determination of elements in steel, testing of stainless steel for aircraft, glass-to-metal seals, and the properties of alloy cast irons showing acicular structure. An index to the previous volume is included. Copies of this publication may be obtained, free of charge, from the Mond Nickel Company, Limited, Grosvenor House, Park Lane, London, W.1. Individuals are requested to give the names of their firms or indicate the nature of their interest.

Makers of Durez

The name and address of the makers of Durez, a plastic material for coating the inside of castings to form a watertight seal and which is bonded through the application of heat by means of low- and high-pressure steam, is Durez Plastics & Chemicals, 1911, Walck Road, No. Tonawanda, N.Y.

SALVAGE ALL PAPER

The Disposal of Molten Cupola Slag

DESIGN OF A SLAG-CASTING MACHINE

By J. HIRD*

The economical handling of cupola slag as it leaves the cupola has not received the amount of thought and planning that other aspects of cupola operation have had. This may be due to the fact that slag is a by-product and its disposal does not affect the production of good castings.

In these days of labour shortage, any saving of man-power is of importance, and the following scheme for handling slag may be found to be of assistance in saving labour, when modified to suit individual requirements.

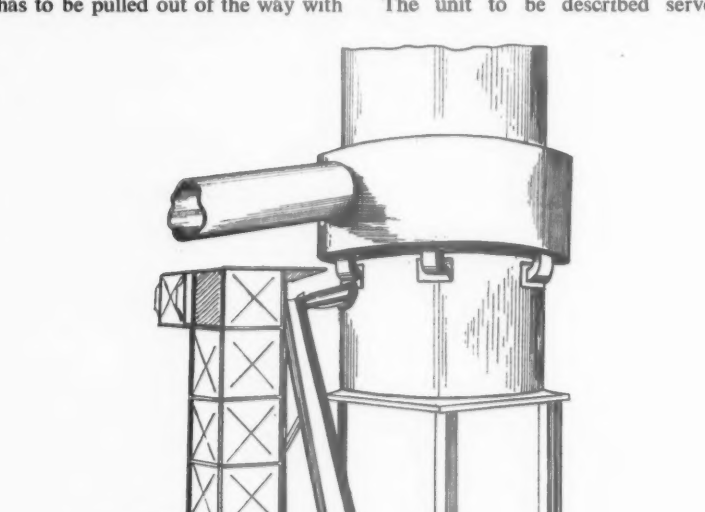
Cupola slag, on leaving the slag spout, is often allowed to run on to the floor, and is left until next day, when it incurs considerable labour for breaking up and removal. In some instances it has to be pulled out of the way with a hook whilst still hot, to make room for more slag. Another method frequently used is to run the slag into an old bogey or barrow, wheeling it out into the yard to tip up whilst still molten. Both methods leave much to be desired, the former needing much time and labour to clear up; the latter method is very fatiguing and requires a suitable place for dumping near the cupola, to avoid handling a second time.

After several experiments with water sprays and tanks, in an attempt to granulate the slag, it was found that a considerable volume of water was required to maintain granulation. The incidence of steam is undesirable in the foundry, where the maintenance of a pure atmosphere is already difficult, and the whole job is inclined to be messy.

A somewhat novel method of dealing with cupola slag has been developed. It consists of running the slag down a spout into a series of troughs, similar to those used by blast furnaces on the mechanical pig-casting machines. The troughs are mounted on a frictionless bogey, which is pulled along under the slag spout as each trough is filled with slag. The slag sets off in 10 to 15 min., and the trough is then turned over, the pig of slag falling on to the floor. The troughs are then returned to their original positions and are ready for the next slagging out. There is sufficient room under the troughs for a considerable number of the pigs, which can be left until the cast is over, or, as they are easy to handle, can be picked up on a shovel, loaded into a barrow, and wheeled away as time permits.

The number of troughs required to deal with the slag from each slagging out depends on the size and working conditions of the cupola, including the length of time between slagging and the melting rate.

The unit to be described serves a 36-in. cupola with a well bricked in to 27 in. dia., which has a capacity of about 12 cwts. of molten iron. The melting rate averages 3 tons per hr.; 6-cwt. charges are used and 25 lbs. of limestone is added to each charge. Slagging out is done at hourly intervals.



ARRANGEMENT OF SLAG-CASTING MACHINE FOR DISPOSING OF MOLTEN CUPOLA SLAG.

Metal which comes down with the slag sinks to the bottom of the pig. When the slag sets and the pig is turned out, it is recovered in the form of a nugget at the bottom of the pig. This represents quite a considerable saving, as all the metal in the slag is recovered in this way; it is really remarkable the way the iron separates out. Small clean nuggets of iron are recovered, even from the first pigs in the cast, when small quantities of iron are blown out with the slag. When iron appears with the slag, at the end of slagging out, this forms quite a fair-sized ingot in the bottom of the last pig.

Description

The slag emerges from the cupola down the usual type of short slag spout. Facing this a cast iron box is built, of 18-in. square cast-iron plates with a flange, and equidistant cored holes, for bolting together. A sliding door is arranged opposite the slag spout for opening the slag hole, and bolting it up at the end of slagging out, when the blast is shut off for a minute.

After opening the slag-hole the door is closed and the sparks, small pieces of coke, and flames, go down the box, through an opening arranged at the bottom of the box, and are blown out under the cupola. A spout 6 ft. long made of 8 in. by 4 in. channel iron is fastened on the side of the box, at an angle of about 25 deg. with the horizontal, the lower end being located over the troughs. Seven troughs are required to deal with the slag produced at each slagging. If filled with iron, the pig would weigh approximately 1 cwt. Each trough holds 60 lbs. of slag, and an average slagging produces 3½ cwts. of slag. The troughs are made from a pattern made by using a cast-iron pig from a well-known brand of mechanically-cast pig-iron. Trunnions with two flat sides and semi-circular ends are cast on the trough so that when turned over it returns automatically to a horizontal position. A square stub is cast on one end, and the troughs turned over with a cranked handle which fits over the stub.

The Bogey

The frictionless bogey which carries the trough is 7 ft. 6 in. long, and is built up of 6 in. by 3 in. channel iron welded together. Four 3 in. diameter flanged rollers carry the bogey on a frame the same length and size as the bogey. The overhang of the bogey over the frame as it moves to each end of its travel is taken care of by a further frame of 3 in. by 1½ in. channel iron 14 ft. by 6 in. long, which rests on the floor and is bolted on the first frame. On each bogey corner, a jockey wheel or steady is arranged to run on the 3 in. by 1½ in. frame.

These wheels are mounted in brackets and bolted on the bogey through slotted holes and set to run on the frame without taking any of the major weight of the bogey, which is carried by the frictionless rollers. An eye bolt is fitted at each end of the bogey for advancing it with a hooked rod as each trough is filled.

The slag which remains in the long spout after slagging is easily removed if allowed to cool for a few minutes. The spout is not lined in any way, but a small piece of firebrick placed in the top of the spout at the point where slag enters from the short slag spout, will prevent the spout from getting too hot and distorting.

It was thought that the pigs of slag would be suitable for disposal as road making material, being of a fair size and evenly shaped, but when quite cold they are very brittle and break up into small pieces. If removed from the troughs and under the bogey whilst warm they can be handled in one piece, but break up on cooling. Although intermittent slagging is adopted on this unit, it could be worked with equal success with the slag hole continuously open.

Photo-electric Control for Bessemer Converters

Bessemer converters of the Jones and Laughlin Steel Corporation are equipped with a flame-control device that depends for its effectiveness on the photo-electric cell. According to Dr. H. K. Work, who described the improvement at a recent meeting of the American Institute of Mechanical Engineers, an autographic record of the flame intensity is made for the entire blow, and filters are needed to absorb the heat rays and to take advantage of a selective range in the spectrum. The photo-electric cell is used throughout the blow, but its greatest value is in detecting the beginning and end of the "after blow." The average length of the latter is 16 secs., and its end must be determined within 2.5 secs. If this period is exceeded, oxidation and absorption of nitrogen occur; the resultant product is characterised by increased ageing, blue brittleness, and low-temperature brittleness; and the mill loss is high. With the cell it is possible to keep within the prescribed limits and thus to cut down the mill loss to a marked extent. In addition, a considerable saving is effected in manganese because less is required for deoxidation.

* Foundry Manager, Higgs Motors Limited.

The Fluidity of Cast Steel*

SPIRAL TEST MOULDS FOR FLUIDITY MEASUREMENTS

By HOWARD F. TAYLOR and EDWARD A. ROMINSKI†

Efforts to obtain the best possible steel casting require not only that composition be held to rigid specifications, but also that fluidity (variously termed castability, life, fluid life, runability or shankability) must be such that the moulds will be readily and satisfactorily filled.

Porous and incompletely run castings, lapped surfaces and unfaithful mould reproduction can often be laid directly to the sluggishness of the steel used for pouring. Badly skulled ladles are not an uncommon problem, and it has been suggested from time to time that the efficiency of risers, centre-line weakness, resistance to hot tearing and similar characteristics may be influenced by the fluidity of the casting metal.

With this in mind, the U.S. Naval Research Laboratory undertook to develop a mould and technique suitable for measuring the flowing quality of steel in the furnace in order to determine the proper tapping time. The laboratory also sought to develop a modification of this test to enable foundrymen to determine the fluidity of the steel in the ladle at any particular time. What was sought in this investigation was a test-piece which should be capable of measuring accurately small variations in fluidity and yet faithfully evaluating maximum and minimum values which result from extreme conditions of temperature and composition. Too, the test mould should be simple, inexpensive to make and convenient to prepare, easy to manipulate and to read directly. Accurate levelling should not be necessary, and provision should be made for maintenance of a constant flow head or at least one which varied within narrow limits. Finally, results from the test-piece should be reproducible.

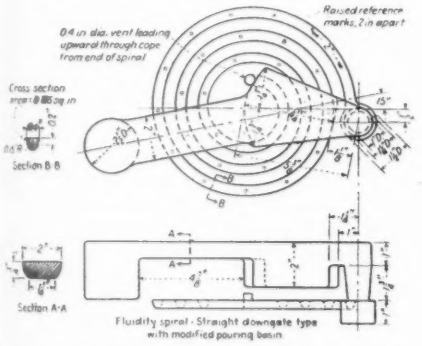

0·4 in. dia. vent leading upward through cope from end of spiral
Raised reference marks, 2 in. apart
Cross section area = 0·05 sq. in.
Section B-B
Section A-A
Fluidity spiral - Straight downgate type with modified pouring basin

FIG. 1.—CONSTRUCTION DETAILS OF A SPIRAL FLUIDITY TEST PATTERN FOUND MOST SATISFACTORY FOR HALF-TON OR SMALLER LADLES.

The spiral type of test-piece for measuring the fluidity of cast metals was proposed as early as 1919, but it remained for Saeger and Krynitsky, of the National Bureau of Standards, to adapt it for use with cast iron and non-ferrous metals. The work was published in 1936, and later this test became an A.S.T.M. standard for measuring the fluidity of these metals.

Previous Experiments

Several attempts have been recorded where a spiral flow channel has been tried with cast steel, but little success was reported. Some time prior to 1936, Ruff found the spiral not fully satisfactory, and concluded that dynamic laws applied more directly when straight flow channels were employed. Accordingly, he developed a test for use in measuring the fluidity of cast steel which involved a straight cylindrical flow channel of $\frac{3}{16}$ in. diameter fed through a simple conical runner. In all tests discussed, the flow channel was made in sand moulds of either the green or air dried type. The straight flow channel has been used extensively in Great Britain for both research and plant testing and to some extent in America. Opinion varies widely on the effectiveness of this method of testing for routine foundry practice.

Kron and Lorig, working at Battelle Memorial Institute, published the results of work on the subject in 1940. They used straight flow channels, $\frac{7}{32}$ in. diameter, and their mould was an improvement over that of Ruff because of the inclusion in the design of a carefully controlled ferrostatic head which governed the entry of metal into the flow channel.

From a careful study of the results obtained by the various investigators using the straight flow channel, it was apparent that this type offered little promise as a foundry tool. Test values were not dependable, and lengths of flow were very short. However, several tests were made at the Naval Research Laboratory before this type was discarded in favour of the spiral type. The results of preliminary tests at the laboratory indicated that the Ruff mould, unless provided with means for controlling the ferrostatic head and regulating the flow of metal, did not give consistently reproducible results and experimental points were badly scattered. The tests also showed that the $\frac{3}{16}$ in. diameter flow channel failed to give significant lengths of flow in steels which were still fluid enough to fill a mould. The maximum lengths of flow for steel of average analysis at normal pouring temperature were never greater than 12 in. It was impossible, in this size channel, to measure accurately small variations in fluidity. It was also found that the mould employing a straight flow channel required careful levelling before pouring.

Because of the success reported when Saeger and Krynitsky used the spiral mould for measuring the fluidity of cast iron, this type offered more promise as a test for cast steel. Accordingly, this type was next tried, and after the modifications necessary to adapt it to steel, a satisfactory test was developed. The details of the final design are given in Fig. 1, and steps in preparing a test mould are shown in Fig. 2. Fig. 3 shows the arrangement of a test mould.

In order to standardise the method, however, it was necessary to determine the influence of variables, in particular to determine the effect of sand grain size, of green, dry, and cement sand, pouring height, and in the case of tests at the arc furnace, to determine the effect of time of holding the sample in the spoon before pouring and to determine the amount of aluminium to be added to the spoon sample. The results of such tests as were found necessary to evaluate these variables are summarised below.

Summary of Investigations

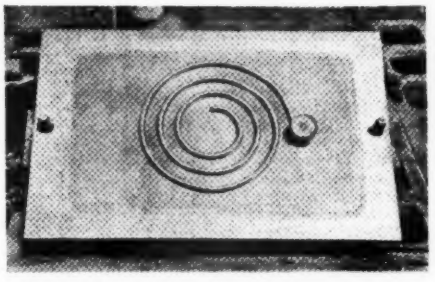
Nearly all of the development work was done using a 300-lb. induction furnace, as melting and sampling were greatly simplified and results were fully as applicable as though all tests had been made on spoon samples taken from the arc furnace. From the results of this work the following conclusions may be drawn:

(*a*) The spiral test-piece, as finally adopted, is satisfactory for evaluating the fluidity of cast steel. Results are reproducible, and the mould is simple and convenient to prepare. Reference marks on the cope surface of the casting make it read directly.

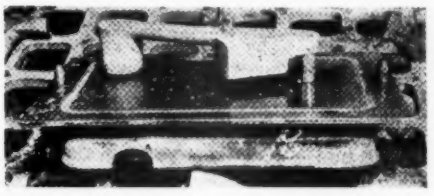
(*b*) Variations in sand grain size from A.F.A. fineness number 53 to 123 showed no selective influence on casting length. Moulds made from bentonite-bonded green and dried sand, and cement sand, when poured under identical conditions, gave equal spiral lengths. Thus the test is not sensitive to any normal differences in the various moulding practices, and results from all foundries would be comparable.

(*c*) Within reasonable limits (variations from 2 to 10 in. above the pouring basin) pouring height did not affect the reproducibility of the test.

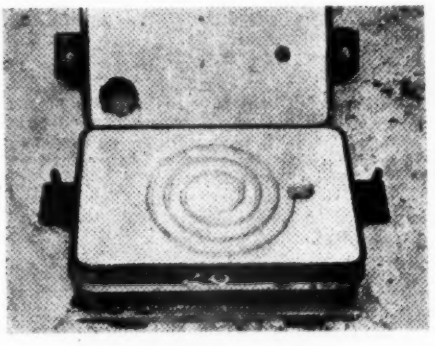
(*d*) Varying the amount of aluminium added to 10-lb. spoon samples taken from the arc furnace indicate that 0.4 oz. (strip $\frac{3}{16}$ in. by $\frac{1}{16}$ in. by 12 in.



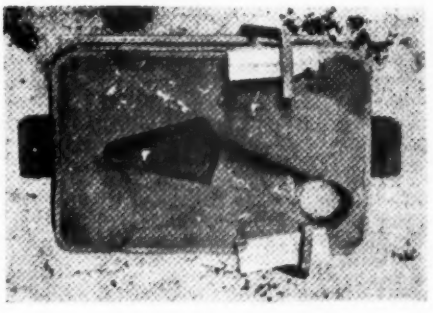
A.—DRAG SECTION, SHOWING BLIND RESERVOIR.



B.—COPE SECTION WITH POURING BASIN PATTERN IN PLACE. NOTE RAISED REFERENCE MARKS.



C.—COMPLETED MOULD, READY FOR CLOSING.



D.—ASSEMBLED AND CLAMPED MOULD, READY FOR POURING.

FIG. 2.—STEPS IN PREPARING TEST MOULD.

* From "The Iron Age," where this article is published by permission of the U.S. Navy Department.

† The authors are associate metallurgist and assistant metallurgist respectively of the Naval Research Laboratory, Anacostia Station, Washington, D.C.

The Fluidity of Cast Steel

long) was the proper amount for average heats of plain carbon (0.15 to 0.30 per cent. C.) steel in the unkilled condition.

(e) In testing at the arc furnace the time normally required to pour the fluidity test casting from the instant of dipping is about 4 secs. To determine what variation might exist as the speed of the operator varied from plant to plant, tests were made which proved that it was possible to hold the metal in a well-slagged spoon as long as 15 secs. without invalidating the results of the test.

(f) Composition has a marked influence on fluidity, the magnitude varying with the nature and amount of the alloying element. The state of oxidation of the bath is a major factor governing fluidity. Results indicated that a critical amount of deoxidation was essential to maximum flow. Variations above or below this value resulted in shorter spiral lengths for any given temperature.

(g) The temperature of the steel was found to have a predominant influence on casting length. The relationship for ordinary analyses is not a linear function as the temperature increases from 1,500 deg. C. to 1,700 deg. C. The increase in test casting lengths resulting from an increment of temperature change decreases at the higher temperatures.

Preparing Test Moulds

Ordinary moulding technique is used in preparing the moulds, and the moulds may be either green or dried sand. If dry or cement sand is employed, it is necessary to dry the moulds assembled to prevent fins which would otherwise lead to poor results. In making tests with this mould (shown in Fig. 2), the steel is poured into the runner guide, builds up to the lower overflow level, runs into a pouring button, and hence into the spiral. A second overflow trough, ¼ in. higher than the first, empties into a catch basin. This arrangement prevents the ferrostatic head from changing more than about ¼ in. and provides a smooth flow of metal into the spiral. A completely filled casting weighs 12 lbs. when the overflow basin is filled. The usual test weight, however, is 8 lbs. as it is not desirable to fill the overflow completely.

The testing technique finally adopted as standard practice for use with the laboratory one-half ton, 3-phase arc furnace has proved very satisfactory. The mould is placed in position near the furnace door. The sampling spoon holds about 10 lbs. of steel and is welded to a ¼-in. dia. rod 8 ft. long. A coil of aluminium ⅜ in. by 1/16 in. by 12 in. long wound on the end of a small rod is also required. These are all the essential requirements for the test.

Whenever a test is desired, the operator warms the spoon and slags it carefully. The sample is taken at a point as near the centre of the bath as possible and is quickly drawn from the furnace. As the spoon crosses the door sill, a second operator vigorously stirs in the small spiral of aluminium for deoxidisation. He does this while the man handling the spoon is moving it into pouring position and does not interfere with the test. The spoon is then dumped without loss of time into the runner guide. It has not been found necessary to slag the sample in the spoon, but this may be done if desired.

The spiral immediately solidifies and can be shaken out of the mould and its length observed. The reference marks on the cope surface of the spiral are 2 in. apart and facilitate reading the length of flow which is taken as the index of fluidity. The aluminium only needs to be used for tests prior to final addition or when necessary to ensure a killed sample, but as long as a standard practice is observed it will be satisfactory to use it at all times.

Tests Prove Advantageous

From routine use of this test on all heats made in the laboratory arc furnace, definite advantages in better steel and cleaner ladles have resulted. Not only has it been possible to follow the progress of the heat to determine the proper tapping time, but it has been possible to determine the effects of changes in slag or charging practice, alloying elements, and type, amount, time, and order of adding deoxidisers. Rapid changes in fluidity as a result of suddenly increased or decreased power input can be readily detected.

For example, one test was made on relatively cold steel giving a spiral length of 10 in. A subsequent test taken 10 mins. later while the power had been raised sharply gave 17 in. Tests taken before and after final manganese additions gave 18 in. and 18¼ in., respectively, whereas tests 3 mins. later, before and after final silicon additions, gave 18½ in. and 26 in., respectively. Fluidity was greatly improved by the addition of silicon, but was not changed by the manganese.

One series of tests involved measurements at the furnace as well as on the pouring floor. Just before adding the final additions of manganese and silicon the length of spiral was 17 and 16¼ in. on two tests. Following the addition the flow increased to 20 and 20¼ in. At this point the bath was rabbled and tapped and optical pyrometer readings indicated the temperature as 1,607 deg. C. Using a ½-ton capacity teapot ladle a mould was poured taking about 300 lbs. of metal. Next two fluidity test-pieces were poured and flow had fallen to 16¼ and 16½ in. as a result of heat loss to the ladle and atmosphere, the temperature indicated as 1,500 deg. C.

Two more large castings were poured, and then three spirals were poured in order at one minute intervals. Only a small amount of metal was left in the ladle and temperature was falling rapidly. The casting lengths were 15¼, 14, and 12 in. in the respective pouring order. The temperature was estimated by quick pyrometer readings to be about 1,471 deg. C. for the last mould. It was found possible by associating the length of spiral obtained at the furnace before tapping with the manner in which the steel handled on the pouring floor and with the quality of castings obtained, to

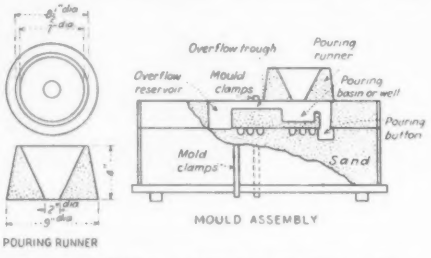


FIG. 3.—MOULD ASSEMBLY OF SPIRAL TEST PATTERN SHOWN IN FIG. 1, AND DETAILS OF POURING RUNNER.

predict the casting behaviour of any heat of steel. Spiral lengths of at least 20 in. are required before the addition of final deoxidisers in the practice at the Naval Research Laboratory. This usually results in a spiral length of 25 to 28 in. just prior to tapping. Thirty-two to 36 in. final fluidity is recommended for larger heats where more moulds must be poured.

Following the satisfactory application of the spiral mould for fluidity measurements at the half-ton furnace at the Naval Research Laboratory, tests were made using the 3-ton furnace at the Washington Navy Yard. In this case removal of the sample was thought to be complicated by the more intense heat from the larger door opening and the greater distance to the centre of the bath. Planning for this, a larger and heavier spoon was welded to a 1½-in. diameter iron bar about 4½ ft. long. A pipe section 4 ft. long was then welded on the bar to give an overall length slightly greater than 9 ft. without unnecessary weight.

The heavy iron bar was necessary to prevent bending from the weight of sample when the rod heated up near the spoon. The technique for handling this sampling spoon is the same as for the smaller one used at the half-ton furnace except that as it is drawn from the furnace, two extra men are needed to support the sample and move it into position for pouring. This is done by means of a cross bar slipped under the rod at any convenient point between the sample and the operator.

Several satisfactory tests were made in this way, but it was later found that sampling could be done with the smaller spoon which requires only a single operator. In larger furnaces, however, this might be impossible and the use of the larger spoon would be necessary. The total time for making the complete test is well under 2 mins., so the use of four men (three to handle the spoon and one to stir in the aluminium) is not a disturbing factor.

Results obtained from this work at the Washington Navy Yard are few because the method has only been tried for a short time. Tests taken before and after final deoxidising additions to the furnace gave 26 and 36 in. of flow respectively on a plain carbon heat of approximately 0.20 per cent. carbon. A nickel steel heat from which a spiral was poured just before tapping gave 49 in. flow. This steel was known to be more fluid than plain carbon steels because of the presence of 3½ per cent. nickel.

Large Test-Piece

The small mould previously described is satisfactory for half-ton or smaller ladles, but is unsatisfactory for larger bottom pouring ladles because of the rapid rate of flow of steel from the nozzle. At the request of the Norfolk Navy Yard for a method of measuring fluidity of cast steel under these conditions, the test-piece was designed. This is merely a large scale modification of the smaller fluidity test mould. Principles of flow are identical and measurements made by the appropriate use of either test are comparable.

The moulds can be made of green sand if desired but dry sand is preferable when they are allowed to stand unused for more than a few hours. Ordinary moulding methods are used, and the effects of variables are the same as discussed for the small mould. The Norfolk Navy Yard made the mould of cores, thus obviating the necessity for a flask, and moulds were made up and stored for use as needed.

When making a test the ladle nozzle is centred above the pouring reservoir and the mould filled at an ordinary rate. The metal builds up to the level of the overflow into the pouring button and fills the spiral under conditions as free from turbulence as possible. The overflow trough is 0.25 in. higher than the first and limits the variation in ferrostatic head to about this amount. As soon as the metal starts to flow into the overflow reservoir an observer calls "full" and pouring is stopped as quickly as possible. If metal should build up above the level of the overflow, the value of the controlled head would be lessened, and it would be harder to shake the test casting from the mould than it would be the case if pouring were stopped rapidly enough to prevent any metal being left on the slanting overflow.

Tests were made at the Washington Navy Yard, and it was found necessary to place a sand baffle plate in front of the overflow into the spiral to prevent metal splashing or spurting prematurely into the flow channel and interfering with normal flow. This baffle also serves as a skim gate to keep slag or dross from getting into the test channel. A runner guide is always used.

After providing the baffle core, a series of tests was made at the Washington Navy Yard, which proved the test-piece to be satisfactory. Six dry-sand moulds were prepared and placed in position on the foundry floor. Small castings were being poured and several openings were necessary so that there was a large drop in the temperature of the steel between the beginning and end of pouring. A 10-ton ladle was used, and after first pouring a large mould to heat up the nozzle, two test castings were poured. These measured 26 and 25¼ in.

After approximately half the metal in the ladle had been poured into nine moulds, the second pair of tests was taken. Only one spiral filled this test as sand had clogged the flow channel, but the good spiral measured 19 in. After pouring nearly all the remaining metal into 16 moulds, the final pair of tests measured 8 and 7 in. in the order poured. These tests, as well as one more series which gave equally good results, established the spiral mould as satisfactory for measuring the fluidity of cast steel on the foundry floor.

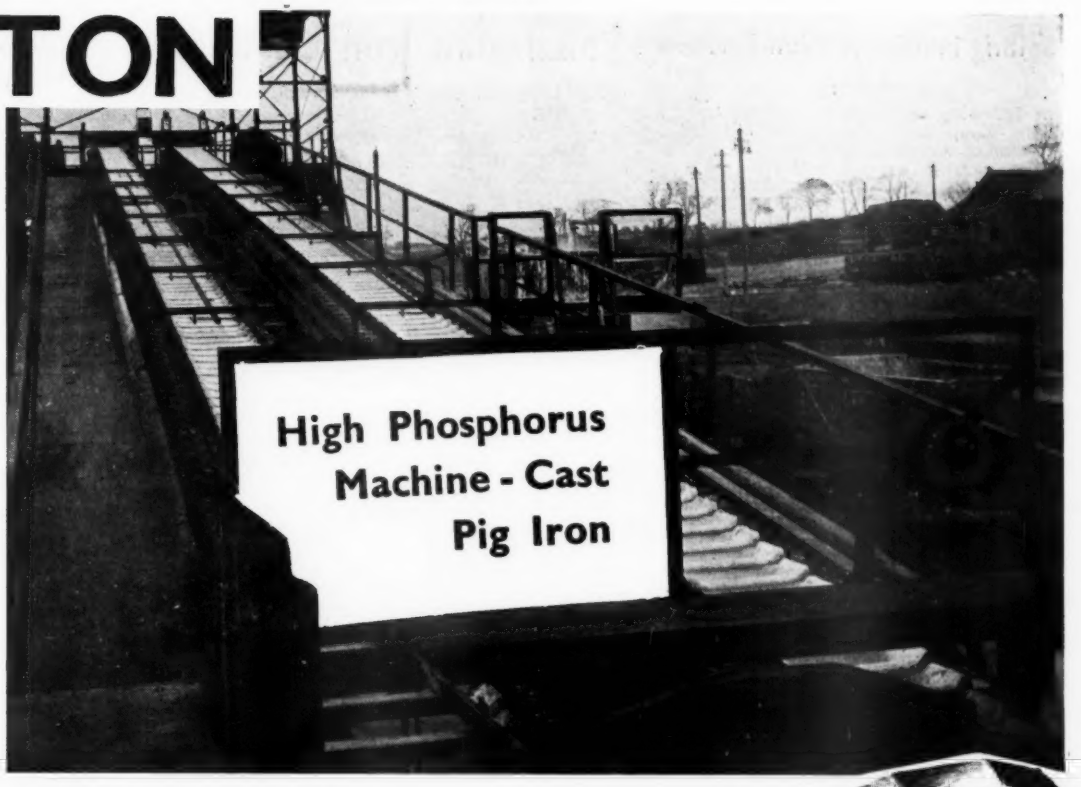
Tests of Practical Value

It is impossible to list all applications for this type of testing as they depend largely upon the individual foundry. For example, a small-casting producer would only be concerned with the fluidity test at the furnace, while the heavy-casting manufacturer would also be interested in the condition of the metal at the time of pouring. By taking tests before, or before and after, pouring a large casting, it would be possible to tell the effect of fluidity on such factors as hot-tear, centre-line weakness, etc.

If aggravated conditions in the cooled casting could be associated with the fluidity of the steel used, many current founding problems would be explained and the foundryman possibly provided with a means for their solution. It might prove

(*Continued on page* 140.)

STANTON



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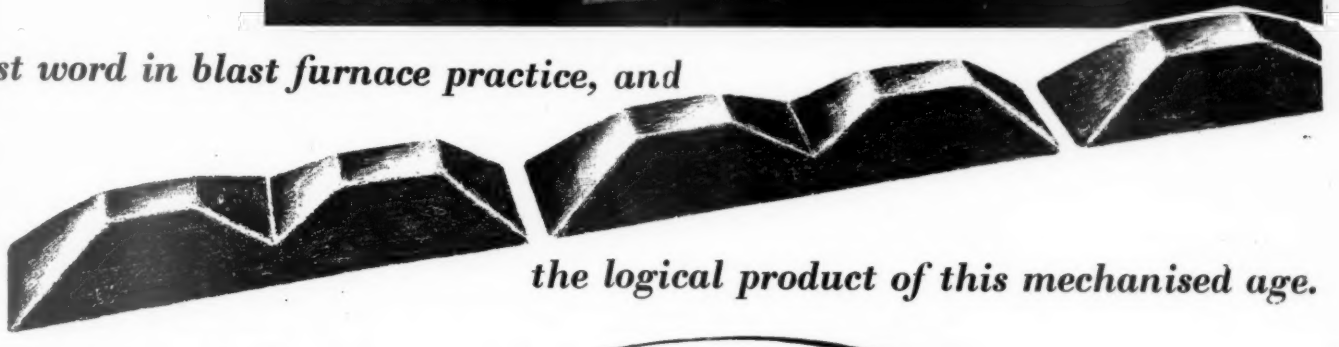

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Selling Prices for Non-Ferrous Scrap

The following are prices for process and manufacturing scrap resulting from strip, sheet, plate and tubes and are intended to represent the current market values. The prices are for the week ended February 21, and are issued from the Office of the Joint Controllers of Non-ferrous Metals. They are all net, per ton, ex-sellers' works, suitably packed:—

Brass.—S.A.A. webbing, £48 10s.; S.A.A. defective cups and cases, £47 10s.; S.A.A. cut-offs and trimmings, £42 10s.; S.A.A. turnings (baled), £36; Q.F. webbing, £49; defective Q.F. cups and cases, £49; Q.F. cut-offs, £47 10s.; Q.F. turnings, £38; other "70/30" process and manufacturing scrap, £46 10s.; process and manufacturing scrap containing over 62 per cent. and up to 68 per cent. copper, £43 10s.; process and manufacturing scrap containing 58 per cent. and up to 62 per cent. copper, £38 10s.; 85/15 gilding metal webbing, £52 10s.; 85/15 gilding defective cups and envelopes before filling, £50 10s.; cap metal webbing, £54 10s.; 90/10 gilding webbing, £53 10s.; 90/10 gilding defective cups and envelopes before filling, £51 10s.

Cupro Nickel.—80/20 cupro nickel webbing, £75 10s.; 80/20 cupro nickel defective cups and envelopes before filling, £70 10s.

Nickel Silver.—Process and manufacturing scrap: 10 per cent. nickel, £50; 15 per cent. nickel, £56; 18 per cent. nickel, £60; 20 per cent. nickel, £63.

Copper.—Sheet cuttings and webbing untinned, £54; shell band plate scrap, £56 10s.; copper turnings (including shell band turnings), £44.

Foundry Instruction

A series of tuition-free foundry instruction courses started in November in the United States, under the joint sponsorship of Rutgers University and the American Foundrymen's Association. The courses given are "Metallurgy and Metallography of Cast Metals," "Melting of Metals in the Foundry," and "Foundry Materials." Each course will be held one night a week under the direction of specialists in various fields.

The Fluidity of Cast Steel

(*Concluded from page* 138.)

practical to mark clearly on the pattern the spiral lengths of the metal to be used for pouring a particular casting. This would facilitate the manufacture of castings ordered from this pattern at some later date when the foundry details had been forgotten.

From the large number of tests conducted with the smaller fluidity mould and from the comparatively few trials made with the large type, several advantages can be claimed for the spiral as an effective medium for measuring the fluidity of cast steel. The mould is simple, convenient to prepare, economical, direct reading, and compact, and results obtained from its use are highly reproducible. No careful levelling is necessary, and the design of the flow channel is such that differences in flow lengths satisfactorily indicate small variations in the fluidity of the steel.

Provision is made for 55 in. of flow, and while this length is seldom reached (never for plain carbon steels at temperatures below 1,700 deg. C.) the difference in flow between extremely low temperatures and high temperatures or between very sluggish and very fluid steels is ample for testing under the most extreme conditions normally encountered.

For a given steel analysis and shop practice, it would be possible to calibrate the spiral directly in temperature units with a probable accuracy of ± 25 deg. C. (45 deg. F.). Such calibration would have to be done using a thermocouple maintained in the steel bath and pouring spirals at small increments of temperature. To date no refractory is available which can be used as a sheath for protecting thermocouples from the corrosive action of basic slags, and temperature measurements in this way are extremely troublesome. Acid slags present no unusual difficulty, however, when quartz is used as a protecting sheath. Since temperature is not always a true criterion of the casting quality of steel, sole reliance on this quantity would many times be misleading. The more valuable calibration would be in terms of results obtained on the pouring floor.

Malleable Iron Castings*

By H. A. Schwartz (Fox Medallist), Manager of Research, National Malleable & Steel Castings Company, Cleveland.

Since even those malleable plants which confine themselves to one shift must still operate their annealing departments on a 24-hr. basis, the problem of increase in malleable iron production cannot ordinarily be solved merely by putting on one or two additional shifts of moulders.

An increased production from a given plant thus usually involves some study of increasing the output of the annealing department. Two types of solution are looked for: Either to make a more annealable iron, or adopt a shorter annealing cycle. Both expedients are subject to definite limitations. An increase in annealing ability by changes of chemical composition finally is limited when compositions are reached in which there is danger of primary graphitisation. These limitations are already rather well understood, but quite obviously anything which is done to ensure constancy of chemical composition makes it possible to have the average analysis approach the danger line more closely without fear that an unexpected variation will produce unusable material. Increased attention to analytical supervision and control is thus indicated.

Shortened Annealing Cycle

In an attempt to shorten the annealing cycle, the operator is limited by certain indispensable considerations. Annealing is accomplished by holding the product a given time, at a given high temperature, the time decreasing as the temperature increases. Unfortunately, the physical properties of the product decrease as the annealing temperature increases. Also, the time which can be saved by raising this temperature from any ordinarily used value to the maximum permissible value is, at best, only a matter of some hours.

Second-stage graphitisation is best accomplished by cooling at the correct rate, through a temperature interval of perhaps 27 deg. C., embracing the critical range. Above and below this critical range, cooling rates may be as fast as any commercial mechanism will permit. It is actually advantageous to withdraw the stock from the furnace at 595 or 650 deg. C. if that is mechanically possible.

The execution of the minimum annealing cycle depends primarily upon the ability to have all parts of the charge change temperature alike and at that rate best suited to the metallurgical purpose. This is largely a matter of furnace design and operation.

The writer has seen many instances where, in order to get more material into a furnace, the size of pot was increased, or the pots set closer together, with the effect of minimising the rate at which heat could be transmitted into the more inaccessible portions of the charge. Such a practice can easily waste more time in slowing up heating and cooling than is gained by the equivalent of a larger amount of castings handled. This condition is particularly critical during the cooling interval if there are great temperature differences in various portions of the same furnace, then the time required in order that every portion of the furnace may cool at the preferred rate will become so great as largely to retard the output.

From the annealing cycle viewpoint, therefore, attention should be directed to uniformity of temperature in a given unit, not overlooking the limitations on the rate at which heat can be transferred from the surface to the centre of the pots used.

* One of a series of short articles appearing in "Metals and Alloys", covering the general subject of speeding up munitions production.

Government Changes

MR. OLIVER LYTTELTON FOR WAR PRODUCTION

Mr. Oliver Lyttelton, who has been appointed a member of the War Cabinet with the title of Minister of State, will take over the functions recently assigned to Lord Beaverbrook when the latter was appointed Minister of War Production. Lord Beaverbrook will shortly go to the United States, where he will carry on the work he began in regard to the pooling of munitions and raw material supplies. Mr. Oliver Lyttelton has been representing the War Cabinet in the Middle East. On his return he will exercise general supervision over the whole field of war production. Before going to Cairo Mr. Lyttelton was President of the Board of Trade. He was Controller of Non-ferrous Metals up to the time of his joining the Government in 1940, and before the war was managing director of the British Metal Corporation, Limited.

Dr. Hugh Dalton, hitherto Minister of Economic Warfare, has been appointed to succeed Col. J. J. Llewellin as President of the Board of Trade. Col. Llewellin has been appointed Minister of Aircraft Production in place of Col. Moore-Brabazon. Viscount Wolmer has been appointed Minister of Economic Warfare, and Lord Portal, Parliamentary Secretary to the Ministry of Supply, succeeds Lord Reith as Minister of Works and Buildings and First Commissioner of Works. Viscount Wolmer, the new Minister of Economic Warfare, has been Director of Cement, Ministry of Works and Buildings since 1940.

New Companies

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

Stacey's Abrasive Wheels, 78, Artisan View, Sheffield—£2,000.

Foundry Chemicals, 285, Long Acre, Nechells, Birmingham—£4,000.

Clinton Engineering Company, 38, Great Charles Street, Birmingham—£2,500. H. C. and E. R. Carver.

Fethney Bros.—Engineers. £10,000. H. Schofield, 5, Headroomgate Road, St. Annes-on-Sea, subscriber.

Mark Doniger (Engineering)—£5,000. M. Doniger, 9, Ballbrook Avenue, Didsbury, Manchester.

Llanthony Welding & Sheet Metal—£4,500. J. E. Taylor, "Sunnymeade," Upton Lane, Barnwood, Gloucester.

Southbury Engineering Company—£20,000. S. Michaels, 27, St. John's Road, London, N.W.11, subscriber.

Huber Engineering Company, Vicarage Street, Luton, Beds—£5,000. J. Shaw, C. Solomon, and S. Huberman.

United Aluminium Foundries—£1,000. H. M. Williams, 545, Nell Gwynn House, Sloane Avenue, London, S.W.3.

Clark & Martin, 5-11, Beacon Street, Liverpool—Engineers, founders, etc. £5,000. James, Joseph and W. Clark.

Electro Precision Gauge Company—£1,000. W. Wild and J. Marshall, 198, Widney Manor Road, Solihull, Warwickshire.

Greenwood Engineering Company, 25, Garlick Hill, London, E.C.4—£2,000. S. H. Highfield, C. H. Short, and W. G. Napper.

Anglo-International Constructional Engineers—£5,000. S. W. Hymans; B. Lynch, 24, Horbury Crescent, London, W.11, subscriber.

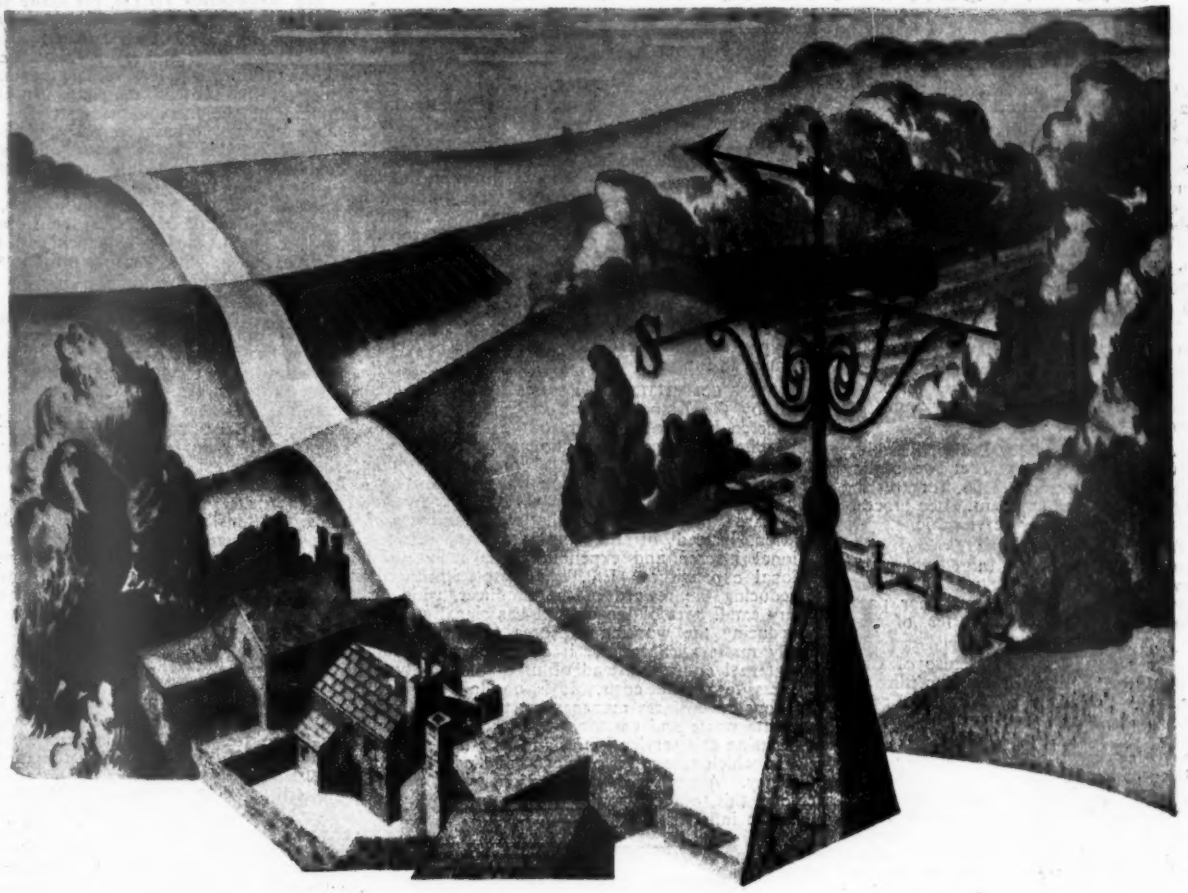
Fredk. Price, Oxhill, Warwickshire—Tool, pattern and machinery designers, engineers, etc. £2,000. F. P. Price and E. W. Wynn.

H. A. Gaydon & Company—General engineers, tool and instrument makers, etc. £2,000. H. A. Gaydon, 147, Shirley Road, Croydon, Surrey.

N. C. Ashton—Manufacturers of and dealers in metals and alloys, etc. £5,000. N. C. Ashton, 36, Longden Avenue, Crosland Moor, Huddersfield.

Bayswater Engineering Company, 63, Belsize Lane, Hampstead, London, N.W.3.—£4,000. R. G. and A. E. P. Backer and H. C. Sellman.

Almex, Exchange Buildings, New Street, Birmingham—Manufacturers and refiners of metals and alloys. £1,000. H. A. Luss and F. Johnson.



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The Week's News in Brief

Trade Talk

THE ANNUAL GENERAL MEETING of the Iron-founders' National Confederation will be held at Grosvenor House, London, on Wednesday, March 4, at 3 p.m.

APPLICATION has been made to the Stock Exchange Committee for an official quotation for 380,000 5s. ordinary shares of Davis & Timmins, Limited, screw manufacturers.

SHEFFIELD UNIVERSITY COUNCIL has gratefully accepted a bequest of £1,200 made to the University by Mr. L. N. Ledingham, to found a bursary fund for students in the Department of Metallurgy.

THE MINISTER OF WAR TRANSPORT has made an Order limiting the weight of packages for conveyance by passenger train to 112 lbs. Prior arrangements with the railway company must be made for heavier packages.

BAKELITE, LIMITED, of Brackley Lodge, Brackley, Northants, have placed on the market two sealing solutions, Bakelite V1845 and N2106, for treating porous castings so as to render them, after processings, pressure-tight and thereby serviceable.

WELLMAN BRONZE & ALUMINIUM COMPANY has opened a magnesium foundry in Cleveland, a centre of non-ferrous castings. It will make castings for aircraft landing wheels and other parts, and has a present capacity of 100,000 lbs. of magnesium alloys monthly.

A LECTURE entitled "The Manufacture of Castings for Piston Rings," illustrated by cine film and lantern slides, will be given by Mr. H. Forrest before the Keighley Association of Engineers at Keighley to-morrow, February 27, 1942, at 7 p.m. The dinner arranged for March 7 has been postponed to a later date.

MR. MARK HODGSON, general secretary of the Boilermakers' Society, states in his monthly report that complaints have been received from workers concerned with welding operations to the effect that they had come to the conclusion that the welding process and the fumes emitted tended to induce a number of maladies. It has been decided to make inquiries into the subject.

THE APPOINTMENT of personnel managers by industrial firms was advocated by Mr. Henry Robb, Leith shipbuilder, when addressing Edinburgh business men. The personnel manager, he said, would be responsible for all matters affecting wages, conditions of employment, etc. The establishment of such a post should be quite apart from production managers and foremen.

THE COMPANIES REGISTRATION OFFICE gives notice that the names of the undermentioned companies have been struck off the register, and such companies are dissolved:—Darlington Rustless Steel & Iron Company, Limited; Gateshead Foundry, Limited; Patent Axle-Box & Foundry Company (1934), Limited; Superstrength Metals, Limited; Vulcan Motor & Engineering Company (1906), Limited; Widnes Foundry (1925), Limited.

LORD BEAVERBROOK, speaking last week in the House of Lords as Minister of War Production, said that America and Britain must increase the production of machine tools at home. It seemed that the machine-tool industry output in Britain could be developed to an amazing extent. The need for economy of tin was pressing. Projects had been launched for consolidating the combined resources of Britain and America in tin, and we should get our due proportion. In the last six or seven months the output of finished munitions had doubled, said Lord Beaverbrook. Although January production of tanks was a record, the first tank week since Sir Andrew Duncan took over the Ministry of Supply was the biggest week's production ever. During January Britain produced two-pounder guns at the rate of 33,500 a year. Britain was now producing quantities of a new heavy tank gun which would penetrate the armour of any German or Italian tank. We must send to Russia shortly under the terms of the protocol immensely increased shipments of tanks and aircraft.

IN THEIR SECOND REPORT, just published, the Committee on Skilled Men in the Services, of which the chairman is Sir William Beveridge, state they have made a close analysis based on the examination of individual experiences of 356 men serving in the Forces, and they find that, while methods of making the best use of skilled men are very good in the Navy, and nearly as good in the Air Force, the Army shows "a continuing failure to use men of engineering skill according to their skill which has surprised us by its extent." The report points out that the task of the Army in this matter is much harder than it is for either of the other Services, or for civilian industry. The report says that the extent to which men of rare skill find that skill unused in the Forces remains disturbing and surprising, the more so in view of the vigorous efforts made in all three services to bring about the remustering and using of men according to their skill. The trade unions have made out their case. They have shown failure to use men according to their skill in a substantial number of cases and have proved the need to take more effective measures in future.

A JOINT COMMITTEE on Excess Profits Tax convened by the Association of British Chambers of Commerce has sent a letter to the Chancellor of the Exchequer directing attention to certain aspects of taxation where, the Committee maintains, adjustments would benefit the national purse and distribute the weight of the burden with greater justice. It is feared, the letter states, that some increases of taxation, instead of reducing the gap between national income and expenditure, have increased national expenditure. E.P.T. is directed primarily at reducing the reward of the producer, which is a very small part of the cost; it has signally failed in reducing the working expenses, which is what chiefly matters. Secondly, it endeavours to apply an external control instead of using the ability of business to reduce costs. It is one of the main functions of business management to seek out and eradicate waste and extravagance. The surest way of securing this service is to admit the incentive of reward which recognises efficiency and penalises inefficiency. A remission of taxation which would achieve this object would operate materially to close the inflationary gap.

Reports and Dividends

(Figures in brackets refer to the previous financial year.)

Clarke Chapman—Dividend of 12½% (same).

Ingall Parsons Clive—Dividend of 4% on the deferred shares (5%).

Braithwaite & Company (Engineers)—Interim dividend of 2% (same).

Davies & Metcalfe—Final dividend of 6%, making 9% (10%) for the year ended December 31 last.

Hammond Lane Foundry—Final dividend of 7%, making 10% (same); to reserve, £3,300 (£2,500); forward, £3,305 (£2,123).

Evered & Company—Net profit for the year to December 31 last, £20,135 (£23,532); ordinary dividend of 10% (same).

Delta Metal Company—Profit, £83,668 (£97,360); ordinary dividend of 12½%, tax free (same) and a bonus of 7½%, tax free (12½%, tax free).

General Engineering Company (Radcliffe)—Net profit for the year to November 30 last, after tax, £10,503 (£8,671); dividend of 20% (15%).

R. B. Pullin & Company—Net profit for the year ended October 31, after tax, N.D.C. and E.P.T., £29,551 (£25,580); dividend of 20% (same).

Smith's Dock Company—Profit to September 30 last, after depreciation, income-tax and E.P.T., £45,152 (£92,282); debenture interest, £8,250 (same); preference dividend, £5,000 (£5,750); ordinary dividend of 6% (same), £30,000 (£34,500); to reserve, £20,000 (£30,000); forward, £19,284 (£42,219).

Burnell & Company—Full report shows: Net profit for 1941, £29,415 (£31,401), after charges, including £15,000 (£11,500) for income tax, £6,000 (same) for depreciation, and £1,995 for war damage insurance; to general reserve, £5,000 (£10,000); participating dividend on preference shares, 1.568d. (same); ordinary dividend 15% (same); forward, £26,211 (£19,607).

Wagon Finance Corporation—Wagon lease interest and other profits for 1941, £55,917 (£62,624); income from investments, etc., £1,135 (£2,753); expenses, tax and N.D.C., £19,410 (£15,139); debenture and loan interest, £27,567 (£35,054); net profit, £7,676 (£12,465); interim dividend of 5% (same), £3,125 (£3,906); final dividend of 5% (same), £3,125 (£3,594); forward, £19,596 (£18,170).

Obituary

MR. ALEXANDER TULLIS, for many years manager of the British Arc Welding Company (North-East Coast), Limited, has died at South Shields.

MR. DAVID R. KEAY, of David Keay & Leslie, Limited, Hillbank Ironworks, Dundee, has died. He was the son of the late Mr. David Keay, founder of the firm.

MR. ERNEST BURY, formerly of Saltburn, who was at one time a director and general works manager of the Skinningrove Iron Company, Limited, has died, aged 67.

MR. WALTER STUART GOODISON, a former managing director of J. Grayson Lowood & Company, Limited, died at Sheffield on February 13. Mr. Goodison, who was 62, retired two years ago owing to ill health.

MR. ROBERT TELFORD, partner in the firm of Gardner, Telford & Hardman, engineers and boilermakers, of Pendleton, Manchester, has died at Colwyn Bay at the age of 94. He was a relative of Telford, the engineer and bridge builder.

SIR ROBERT ELLIOTT-COOPER, who died last week at his home in Surrey, aged 97, was a past-president of the Institution of Civil Engineers. He constructed many railway and other engineering works in Britain, the Crown Colonies and South Africa.

SIR WILLIAM BIGGART LANG, chairman of John Lang & Sons, Limited, lathe manufacturers, of Johnstone, near Glasgow, has died at the age of 73. He was chairman of the Machine Tool Committee of the Ministry of Munitions during the last war and was a former president of the North Western Engineering Association.

Personal

MR. A. J. G. SMOUT, a director of I.C.I. Metals, Limited, has been appointed a Commissioner of the Peace for the City of Birmingham.

COL. H. B. SANKEY, a director of Guest, Keen & Nettlefolds, Limited, and other companies, has joined the board of Harris & Sheldon, Limited.

MR. ALFRED HENRY SAYER, of the firm of H. J. Sayer, iron, tinplate and metal merchants, has been appointed a Justice of the Peace for Birmingham.

MR. W. F. RANSON, of Kiltonthorpe, undermanager at the North Skelton ironstone mines of Dorman, Long & Company, Limited, for 15 years, has completed 50 years' work underground.

DR. G. G. M'DONALD, lecturer in engineering at Glasgow University, has been awarded the gold medal, for 1940-41, by the Institution of Engineers and Shipbuilders in Scotland, for his Paper "Dimensional Analysis of Centrifugal Pump and Blower Performance."

COL. S. J. THOMPSON, D.S.O., M.I.Mech.E., governing director of John Thompson, Limited, Wolverhampton (water-tube boilers, motor frame pressings, etc.), has been elected president of the Institution of Mechanical Engineers, in succession to Mr. W. A. Stanier, chief mechanical engineer of the London Midland & Scottish Railway, whose term of office has expired.

Wills

WALL, A. T., of Cowes, late managing director of J. Samuel White & Company, Limited ...	£39,83
PETHERICK, G. T., of London, late a director of the Hodbarrow Mining Company, Limited	£212,62
BELL, E. H., formerly a director of the Tyne Dock Engineering Company, Limited, South Shields	£82,79
MCQUEEN, D. T. H., of Wishaw, civil and mining engineer, late of the United Collieries, mingham	£62,71
CHAMBERS, SIR CORNELIUS, chairman of Gaskell & Chambers, Limited, brassfounders, Bir- Limited	£4,00

Contracts Open

Londonderry, March 7—Ironwork (cast and wrought), tools, for the Town Council. The City Surveyor, Guildhall Street, Londonderry.

Maltby, March 7—Iron castings for the year ending March 31, 1943, for the Urban District Council. Mr. Morgan R. Jones, engineer, Council Offices, Maltby.

Mountain Ash, March 17—Wrought-iron tubes and fittings for 12 months from April 1, for the Urban District Council. The Surveyor, Town Hall, Mountain Ash.

Marple, March 4—Spun- and cast-iron pipes, rubber-insulated cables, paper-insulated cables, etc., during the year ending March 31, 1943, for the Urban District Council. Mr. A. E. Griffiths, electricity manager, Council Offices, Marple, Lancs.

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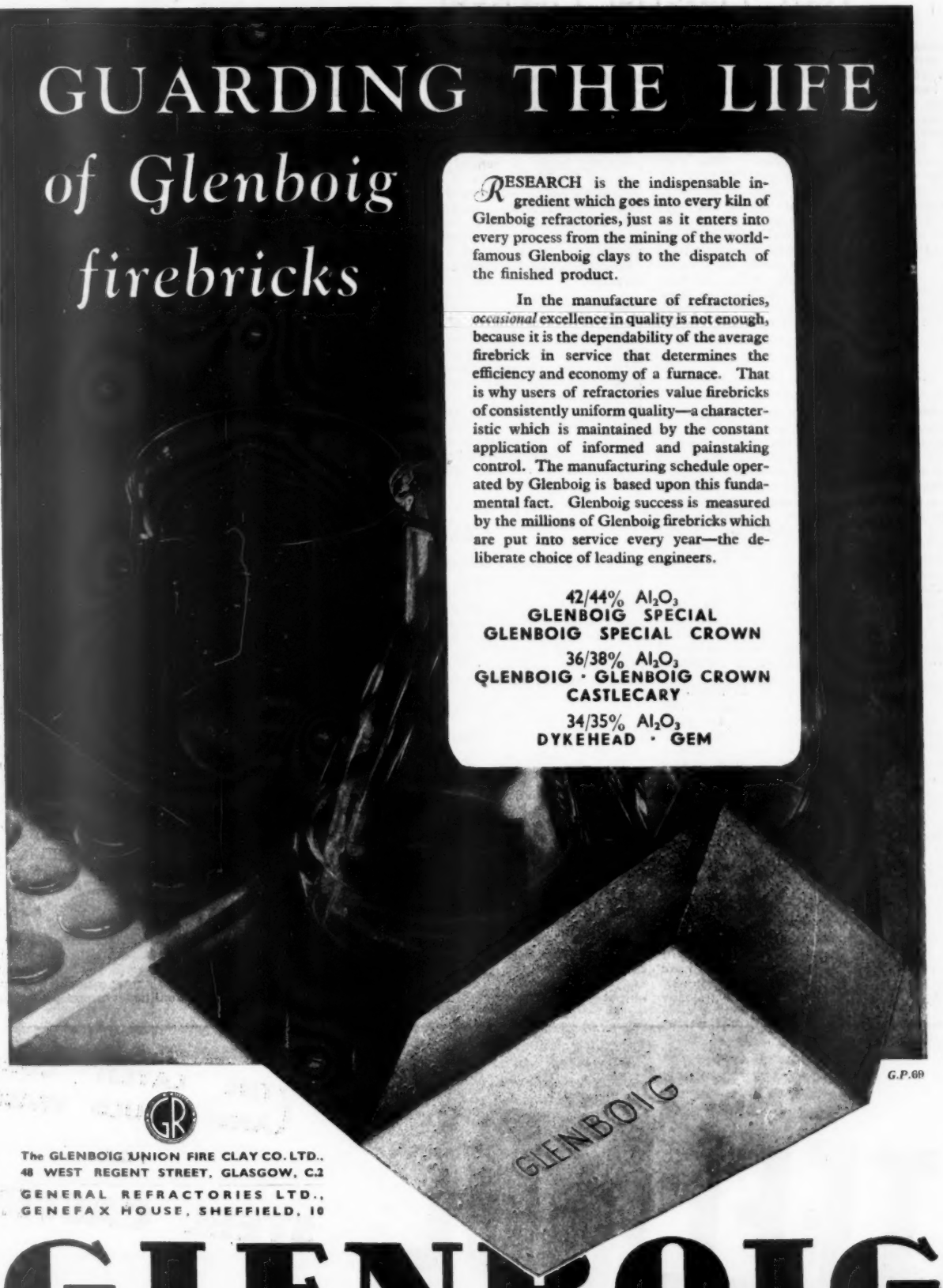

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GLENBOIG

Raw Material Markets

Light-castings foundries are well placed for raw materials, being able to purchase all the high-phosphorus iron they need. This iron is produced from ores located in this country, whereas better-quality irons are made from imported ores. Imports of iron ore are necessarily quite substantial, but it is hoped to reduce them to the lowest possible level, thereby effecting a saving of shipping space required for other cargoes. The light foundries are still anything but happily situated for business, their order-books in many cases being seriously depleted; this state of affairs has been largely brought about by the restrictions imposed on trade in the home market and by curtailment of foreign business. A few foundries which have adapted their plant to meet the needs of Government contractors are in a much better position. Heavy engineering foundries are operating to capacity on defence work, and there are always plenty of orders forthcoming from various Government departments.

Pig-Iron

MIDDLESBROUGH — Midland foundry-iron makers' outputs are quite sufficient to satisfy the demands received from many parts of the country, including the North-East Coast, and deliveries have been very satisfactory. Local consumers formerly used Cleveland iron, but production has been suspended for a long time past, as more urgent orders are on hand for iron suitable for steelmaking purposes. Light foundries are not really busy, so that their demands for iron are much below pre-war levels and are not likely to improve while war needs are paramount. Roughly three-quarters of the iron output in this district consists of basic. The remainder is chiefly made up of refined iron and hematite, the volume of the latter available being much less than what is actually needed. Consequently, more refined iron has been produced and is proving a valuable substitute for hematite.

LANCASHIRE—The majority of light-castings and jobbing foundries are quietly situated, and conditions vary but little from week to week. Prospects are not at all satisfactory, owing to the preponderance of urgent work in connection with the war effort with which these sections cannot deal. Heavy-electrical contractors, machine-tool works, etc., are securing a large amount of business from Government departments and are regularly taking up considerable tonnages of foundry iron from the Midlands. Their requirements are well covered in the main. Special irons and hematite are still difficult to procure and, generally speaking, will only be distributed in cases of proved urgency, the use of alternative grades being encouraged as much as possible.

MIDLANDS—Consumption of high-phosphorus iron in the light-foundry trade shows no sign of material improvement, as works in this section have only a moderate volume of business on their books. Makers of light castings have experienced a steady decline in the tempo of their operations since the outbreak of hostilities, and, as they are not in a position to cope with much in the way of defence work, it is improbable that they will return to more favourable conditions until industry is again on a peacetime basis. Many light-castings works have accumulated stocks of pig-iron, with the sanction of the Control, and fresh deliveries are promptly made as desired. Other iron consumers are less favourably placed, as better qualities than high-phosphorus iron are difficult to get over and above current needs. In fact, hematite is so tight that supplies can only be obtained if an alternative grade is not possible. Very often, however, it is possible to make use of a substitute quality and considerable development has been effected in this direction.

SCOTLAND—The demand for low-phosphorus iron tends to outstrip the supply, and every possible use is being made of high-phosphorus material, which is in plentiful supply. Consumers of the former are not seriously handicapped, and their outputs are maintained at a satisfactory level. Only moderate activity is being experienced in the light foundries in the Falkirk area, and ample supplies of high-phosphorus iron are being sent by Midland producers to cover their restricted needs. Basic iron is fairly plentiful, and the steelworks are taking full advantage of this, but more hematite is required.

Coke

Very few, if any, foundrymen are actually depending on week-to-week deliveries of coke, as they have ample reserve stocks on hand. Some of the smaller foundries were inconvenienced by the recent hold-up of deliveries, but they are now getting supplies through again on quite a fair scale. The price of Durham best foundry coke, delivered Birmingham and Black Country stations, is unchanged at 62s. 9d. per ton.

Steel

Since the beginning of the year there has been a much better demand for structural descriptions of steel, and many producers can now look ahead over some months. Joists and sections are quite well absorbed, while plate makers continue to operate to capacity, orders from shipyards and other consumers being very substantial. Sheet mills have large orders on hand for special qualities, and galvanised sheets are also still being manufactured on a fair scale, but after existing business has been concluded, production of galvanised sheets will be suspended, with the exception of any Government needs which may eventuate. Alloy and special grades of steel generally are in insistent demand in connection with the production of war materials, and every opportunity is being taken to speed up outputs, which are already at an impressive level.

Scrap

Much larger tonnages of iron and steel scrap have been forthcoming since the national campaign was inaugurated recently, but, of course, all the material collected does not necessarily fulfil the requirements of users. It is also somewhat difficult to find adequate supplies of labour to handle the metal, while transport problems have at times presented themselves and caused deliveries to the consuming points to fall behind schedule. Thus, steelmakers and other important consumers are not getting more than they require for current needs. Foundries are able to secure sufficient scrap in most cases, but there is delay in deliveries of certain grades from time to time.

Metals

COPPER—Distribution of copper is on well-defined lines; the Control authorities are meeting the demands of producers of war materials in full, but deliveries in other directions are drastically curtailed, a measure which is inevitable if the future needs of essential consumers are to be safeguarded. Copper supplies have been little disturbed by Japanese intervention in the war so far, but, in view of the sharp changes in the situation from time to time, the authorities are well advised to conserve existing resources to the full extent.

TIN—The effect of Japanese aggression on the tin industry has been very far-reaching, and the output now available to the Allies has been substantially reduced. With the loss of production of Malaya, Siam, the Dutch East Indies, Burma and Indo-China, some 150,000 tons out of a world production of 237,000 tons, based on the 1940 output, are now denied to the Democracies. Further, deliveries from the Chinese tinfields are certain to be considerably lower than usual. Thus, economy in tin will have to be practised very stringently, but sufficient should be available to meet really essential needs for some two or three years, at least.

SPELTER—There is no actual shortage of this metal, but prevailing conditions make it imperative for consumption to be kept as low as is compatible with the needs of consumers using the metal for war production. The quantity of zinc allotted to galvanisers is being sharply cut, and this should have the effect of enabling the authorities to reduce imports of debased high-grade metal and should also benefit the brass industry and other consumers of high-grade zinc. It is reported that the construction of a $1,000,000 plant for the recovery of lead and zinc is to be started shortly in the West Kootenay district of British Columbia. The project is a war development and will be financed by United States funds, and is expected to be in production within six months.

LEAD—The tightening up of distribution of lead has been most pronounced of late, and the tendency will be to curtail deliveries to non-essential users still further. Until comparatively recently supplies of lead were readily handed out for all purposes, but it is now prudent to take into account possible eventualities wrought by Japanese successes.

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